REPORT OF SURVEY CONDUCTED AT

STRITE INDUSTRIES LIMITED
CAMBRIDGE, ONTARIO, CANADA

MARCH 1998

Best Manufacturing Practices

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BEST MANUFACTURING PRACTICES CENTER OF EXCELLENCE
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Foreword

This report was produced by the Best Manufacturing Practices (BMP) program, a unique industry and government cooperative technology transfer effort that improves the competitiveness of the North American industrial base both here and abroad. Our main goal at BMP is to increase the quality, reliability, and maintainability of goods produced by North American firms. The primary objective toward this goal is simple: to identify best practices, document them, and then encourage industry and government to share information about them.

The BMP program set out in 1985 to help businesses by identifying, researching, and promoting exceptional manufacturing practices, methods, and procedures in design, test, production, facilities, logistics, and management – all areas which are highlighted in the U.S. Department of Defense's 4245.7-M, *Transition from Development to Production* manual. By fostering the sharing of information across industry lines, BMP has become a resource in helping companies identify their weak areas and examine how other companies have improved similar situations. This sharing of ideas allows companies to learn from others' attempts and to avoid costly and time-consuming duplication.

BMP identifies and documents best practices by conducting in-depth, voluntary surveys such as this one at Strite Industries Limited, Cambridge, Ontario, Canada conducted during the week of March 16, 1998. Teams of BMP experts work hand-in-hand on-site with the company to examine existing practices, uncover best practices, and identify areas for even better practices.

The final survey report, which details the findings, is distributed electronically and in hard copy to thousands of representatives from industry, government, and academia throughout the U.S. and Canada – *so the knowledge can be shared*. BMP also distributes this information through several interactive services which include CD-ROMs, BMPnet, and a World Wide Web Home Page located on the Internet at http://www.bmpcoe.org. The actual exchange of detailed data is between companies at their discretion.

Strite's history is one of continuous diversification while remaining focused on its core skill of high precision machining. From biomedical implants to jet engines to IMAX cameras, the company has gained a global reputation for engineering excellence by providing its customers with best value solutions to difficult problems. Among the best examples were Strite's accomplishments in design review process; one-stop shopping; and global marketing.

The Best Manufacturing Practices program is committed to strengthening the North American industrial base. Survey findings in reports such as this one on Strite Industries expand BMP's contribution toward its goal of a stronger, more competitive, globally-minded, and environmentally-conscious North American industrial program.

I encourage your participation and use of this unique resource.

Ernie Renner

Director, Best Manufacturing Practices

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Section 1

Report Summary

Background

Strite Industries Limited was founded in 1964 by Joseph Strite, a pioneer in the machining of ultra precision components. This privately-owned company started with eight employees, a few machines, and one customer (Litton Systems Canada). By 1967, Strite's workforce grew tenfold, and the company began diversifying its services in the early 1970s. In 1974, the company received the Government of Ontario's A for Achievement Award, an honor given to few for their outstanding contributions to the province's economy. In the early 1990s, the company initiated an international marketing strategy to expand its business to include its North American customers' manufacturing facilities located throughout the world. Today, Strite specializes in machining small and medium-sized, close tolerance precision components and subassemblies for the aerospace, defense, electro-optical, nuclear, scientific, and other high technology industries. In addition, the company provides engineering and prototyping services, and can usually find solutions to difficult manufacturing, mechanical, and metallurgical problems which few others will attempt.

Strite represents the first Canadian survey for the BMP program. Located in Cambridge, Ontario, Strite employs 220 personnel at its 74,000 square-foot manufacturing facility, and achieved $18 million in revenues for 1997. The company maintains a unique selection of precision machines and manufacturing processes under one roof. By performing its services in-house, Strite can guarantee the quality of its workmanship, and generally improve production lead times for its customers. Among the best practices documented were Strite's design review process; one-stop shopping; and global marketing.

The quote on Mr. Strite's business card says a lot about how he runs his company — "The bitterness of low quality remains long after the sweetness of low prices is forgotten." Strite gained its excellent reputation through the can-do attitude of its employees and the high quality of its products. The company's commitment to its employees and their well-being engenders a sense of harmony, cooperation, efficiency, and family that is serving Strite well as it competes in the global marketplace. By using innovative training methods, the company maintains a highly skilled and motivated workforce who thinks in terms of concurrent engineering with six sigma quality; strives for continuous improvement in the manufacturing process; and finds solutions to seemingly impossible problems on a daily basis. In return, the employees display an unusually high sense of dedication and faithfulness to the company. More than one quarter of the employees have 25 years or more with the company, and there are several examples of multi-generation family members working at the facility.

Strite's history is one of continuous diversification while remaining focused on its core skill of high precision machining. From biomedical implants to jet engines to IMAX cameras, Strite has gained a global reputation for engineering excellence by providing its customers with best value solutions to difficult problems. The BMP survey team considers the following practices to be among the best in industry and government.

Best Practices

The following best practices were documented at Strite Industries:

Item	Page

Form (Crush) Grinding 5

Strite uses form (crush) grinding as the most cost effective manufacturing technique for large volume production (greater than 45,000 units) such as thrust collars for turbochargers and landing gear components. Form grinding is 88% faster than conventional grinding techniques, and has demonstrated a repeatability of 0.0002 inch on a run of 240 pieces.

Process Design Sheets 6

For the past 34 years, Strite has specialized in machining small and medium-sized, close tolerance precision components and subassemblies for customers in a wide variety of industries. To maintain its reputation for high quality, the company developed Process Design Sheets which clearly define each operational step that the machine operator must perform to meet the customer's requirements.

Surface Finishes and Deburr Criteria 6

Strite prides itself in its ability to manufacture precise, high quality, complex parts. Some of these parts require surface flatness tolerances and finish specifications that are difficult or impossible to achieve with conventional machining methods. Strite developed special tooling and skills to machine surface finishes, and can deburr small holes and surfaces, both internally and externally, on complex shapes.

Global Marketing 6

Strite's history is one of continuous diversification while remaining focused on its core skill of high precision machining. In the early 1990s, Strite began expanding its business base to include its North American customers' manufacturing facilities located throughout the world. Today, Strite exports its products to France, the United Kingdom, Italy, Brazil, Japan, China, Korea, and the United States. Export sales account for more than 75% of the company's total sales.

One-Stop Shopping 7

Strite manufactures high technology machined products for the aerospace, nuclear, defense, biomedical, electro-optical, and information technology industries. In addition, the company provides engineering and prototyping services to the scientific and research communities. By providing its customers with best value solutions to difficult problems, Strite gained a global reputation for engineering excellence in machining ultra precision components and subassemblies.

Skills Training 8

During its rapid growth in the 1960s, Strite adopted several innovative employment practices which the company still uses today with excellent results. One of these practices involves the hiring of unskilled workers rather than skilled machinists, which enables Strite to train its employees from the ground up in an apprentice-type program. This program produces a flexible and knowledgeable workforce who thinks in terms of concurrent engineering with six sigma quality; knows the importance of documentation; and strives for continuous improvement in the manufacturing process.

Information

The following information items were documented at Strite Industries:

Item	Page

SPEED System™ Orthodontics 11

Strite provides engineering and prototyping services to the scientific and research communities. The SPEED System™ orthodontic brackets, developed by Dr. G. Herbert Hanson in collaboration with Strite, are respected throughout the world as a superior orthodontic appliance. The SPEED appliance features a miniaturized, self-ligating design and uses resilient spring clips to replace ligatures.

Quality Management System 11

Quality influences a company's ability to attain world-class status. Today's companies face a myriad of quality standards and systems which are imposed by their customers and changing market conditions. Strite is currently implementing ISO 9002 certification. Although the company is renowned for its close tolerance machining capabilities, Strite views the certification process as a welcome addition to its operations, and as a means to attract and keep customers during these highly competitive times.

Point of Contact

For further information on items in this report, please contact:

Mr. Graham Salt
Strite Industries Limited
298 Shepherd Avenue
Cambridge, Ontario
Canada N3C 1V1
Phone: (519) 658-9361, ext. 306
Fax: (519) 658-6925
E-mail: sales@strite.com

Section 2

Best Practices

Design

Design Review Process

Strite Industries Limited uses a Design Review Process on all potential projects to determine whether or not a project is feasible and should be accepted. In addition, this process can identify a manufacturing obstacle before it escalates into an expensive problem. The Design Review Process works as a disciplined system that relies on a high degree of communication and consultation between the Strite team members and the customer. Strite typically handles difficult manufacturing, mechanical, and metallurgical problems that customers submit; however, not all projects are feasible. Only one in every five prospective projects which go through the Design Review Process is accepted.

Strite's philosophy is not to be the lowest cost producer, but instead to provide the best and most cost effective solution for the customer's application with high quality. Every day at 10:00 A.M., a production meeting is held to review new projects, discuss customers' concerns, and identify potential production problems. This meeting typically lasts about 30 minutes. Engineers and operators, as well as quality, supervisory, and marketing personnel participate and contribute to the Design Review Process. The team examines engineering drawings and prototype models, or production pieces for each project. When these are not available, concept or qualification models are prepared for review. Strite's team approach works well, and effectively uses the combined experience and judgement of the company's key personnel. The team can consider all viewpoints and then achieve a consensus on each project.

Another key aspect of the Design Review Process is customer involvement. Through continuous communication, customers ensure that their needs, concerns, and problems are understood by the team. In most cases, the team can electronically share engineering data and drawings with the customers. Strite also works closely with customers to understand their evolving and changing products, processes, materials, and capabilities. This approach allows the company to grow with its clientele, and maintain the knowledge and expertise necessary to meet their needs.

The Design Review Process is a valuable service that Strite provides to its customers. This key process helps to enhance Strite's ability to deliver precision engineering and machining services to customers in a wide range of industries. In addition, the process is an effective way for Strite to focus its capabilities, and keep pace with the growing industries it serves.

Production

Controlling Material Movement

Years of experience in solving tough manufacturing problems has enabled Strite to develop a highly skilled corporate knowledge base in manufacturing processes. As a result, Strite developed the skills and capability to identify material movement up front which may occur during manufacturing operations (e.g., machining, casting, heat treatment). The company carries this same knowledge over to other areas such as machining tolerances, and proper clamping and holding fixtures. By knowing the material characteristics of a part and its end use, Strite can identify tolerances that are impractical, unnecessary, or drive up a part's production cost. The company can also determine the proper clamping and holding fixtures needed to ensure that the specified dimensions are achieved and maintained throughout the manufacturing process.

Strite's customers receive high quality products at a competitive price. By making recommendations that improve the finished part, providing assistance in the manufacturing process, and ensuring that the most cost effective solution is used, Strite has gained a global reputation for machining excellence.

Form (Crush) Grinding

Strite uses form (crush) grinding as the most cost effective manufacturing technique for large volume production (greater than 45,000 units) such as thrust collars for turbochargers and landing gear components. This technique has enabled Strite to supply

more than six million thrust collars to one customer over a 20-year period. The company also operates numerous form grinding machines to produce high speed (180,000 rpm) automotive turbochargers. Strite hardens, grinds, and hones these parts to precise dimensions and stringent tolerances. These tolerances ensure the part's reliability in diesel engines of passenger cars throughout the world.

By using form grinding techniques and precision machines, Strite can achieve concentricities to 0.0005 inch; flatness to 50 millionths; squareness to 0.0003 inch; groove widths to 0.0008 inch; and bores to 0.0004 inch. These specifications are typically required for flight or automotive critical components. Form grinding is 88% faster than conventional grinding techniques, and has demonstrated a repeatability of 0.0002 inch on a run of 240 pieces.

Process Design Sheets

For the past 34 years, Strite has specialized in machining small and medium-sized, close tolerance precision components and subassemblies for customers in a wide variety of industries. To maintain its reputation for high quality, the company developed Process Design Sheets which clearly define each operational step that the machine operator must perform to meet the customer's requirements.

The manufacturing process for each job is developed by an integrated work team consisting of engineering and production personnel. The team analyzes the job to determine the necessary number of operational steps and the best sequence to produce the finished part. Each operational step in the process is numbered using basic programming techniques (e.g., 10, 20, 30) that allow additional steps to be inserted should the process require modification. After the operational steps are identified, they are recorded on a standard Process Design Sheet. Each step's specifications are verified and approved by the Quality Department prior to the sheet being issued to the shop floor. This sheet accompanies the job throughout the manufacturing process, and serves as a valuable tool for the machine operators.

Strite's Process Design Sheets provide clear and comprehensible instructions and specifications for the machine operators. These sheets outline each step in the process, eliminate inaccurate interpretations, and promote consistency of the finished part during the manufacturing process. Strite also encourages its employees to suggest possible improvements, and incorporates these ideas into the process for future jobs.

Surface Finishes and Deburr Criteria

Strite prides itself in its ability to manufacture precise, high quality, complex parts. Typical manufacturing materials include a wide variety of alloys, synthetics, plastics, and ceramics. Some of these parts require surface flatness tolerances and finish specifications that are difficult or impossible to achieve with conventional machining methods. Strite relies on its competent, dedicated workforce; its corporate knowledge base; and its state-of-the-art machine tools to solve difficult manufacturing, mechanical, and metallurgical problems which few others will attempt.

Strite's corporate knowledge base covers manufacturing processes from numerous industries (e.g., aerospace, defense, electro-optical, biomedical, automotive, communication satellite). Using this knowledge, the company can produce exact, close tolerances on complex precision parts. The company also uses a repeatable, well-defined, quality control system to maintain the highest level of quality throughout the manufacturing process. Special tooling and gauging along with a well trained, dedicated workforce enables Strite to maintain its leadership in the manufacture of small to medium-sized components. Because of the size and shape of these components, Strite developed special tooling and skills to machine surface finishes. The company can produce an optical flat surface finish of N1 (mirrorlike and flatness of one light band). This type of flatness eliminates costly seals by allowing a metal-to-metal seal. Strite can also deburr small holes and surfaces, both internally and externally, on complex shapes. Many times, the deburring process requires detailed hands-on attention by the operator, so as not to change the shape or mar the surface finish of the machined part. This attention to detail ensures that the finished parts manufactured by Strite meet all of the acceptance requirements of its customers.

Management

Global Marketing

Since its beginning in 1964, Strite has experienced excellent growth from an initial workforce of eight to more than 220 employees today. The company started with a single customer and, through diversification, developed a wide range of clientele in the aerospace, medical, nuclear, and automotive industries. Major customers include Litton Indus-

tries, IMAX Corporation, Ontario Hydro, Menasco Aerospace, and Allied Signal. Much of the company's growth came from the aerospace industry sector. Today, Strite is involved in developing landing gear and jet engine components. The company also retained and expanded its projects into other high technology industry sectors. Strite's history is one of continuous diversification while remaining focused on its core skill of high precision machining.

Until recently, the majority of Strite's business was primarily with companies in North America. Although it developed a very good reputation with its North American customers, Strite realized that these companies had divisions and subsidiaries with similar high precision machining needs all over the world. In the early 1990s, Strite began an international marketing strategy focused on these potential customers. A full-time Director of Marketing was hired, and the company began expanding its business base to include its North American customers' manufacturing facilities located throughout the world. Today, Strite exports its products to France, the United Kingdom, Italy, Brazil, Japan, China, Korea, and the United States. Export sales account for more than 75% of the company's total sales. This marketing strategy has increased Strite's sales threefold from about $6 million in the early 1990s to more than $18 million today.

A world market strategy offers excellent opportunities for growth and new business in the precision machining industry. Currently, Strite has only three or four competitors in this market. Strite's strategy is to continue developing this global market, while maintaining the company's position as a world-class supplier of precision machined products for the global aerospace, medical, nuclear, and automotive industries.

One-Stop Shopping

Over the past 34 years, Strite has grown from an eight-person machine shop to a 220-person facility specializing in high precision manufacturing and diversified problem solving. Strite manufactures high technology machined products for the aerospace, nuclear, defense, biomedical, electro-optical, and information technology industries. In addition, the company provides engineering and prototyping services to the scientific and research communities. Strite addresses new projects with highly skilled teams of engineers, metallurgists, machine artisans, business managers, quality control experts, and production experts. For maximum effectiveness, the company uses state-of-the-art computer programs (e.g., AutoCAD, Vellum) to run its computer numerically controlled (CNC) machines. Strite can also draw on its close ties with the University of Waterloo and the University of Toronto for additional expertise when solving difficult problems.

Strite maintains a wide range of machining and metallurgical capabilities/tools including jig boring; laser welding; precision Swiss grinding and machining centers; and 30 modern CNC machines. The company is one of only three in the world that can perform electrical discharge machining (EDM) to specified tolerances on the order of 0.0001 inch. Using the latest in precision metal removal machine tools, Strite's technicians determine the customer's needs and perform such processes as material analysis, metal removal, EDM, grinding, turning, honing, plating, heat treating, deburring, and inspection to tolerances as small as 0.00002 inch. Technicians typically machine various materials (e.g., synthetics, plastics, ceramics) and specialty metals (e.g., inconel, titanium, magnesium, steel, nickel, brass, bronze, copper, iron) to exacting tolerances. Figure 2-1 depicts a precision set-up of a CNC lathe; the form grinding of cylindrical components; and the super precision chucking department.

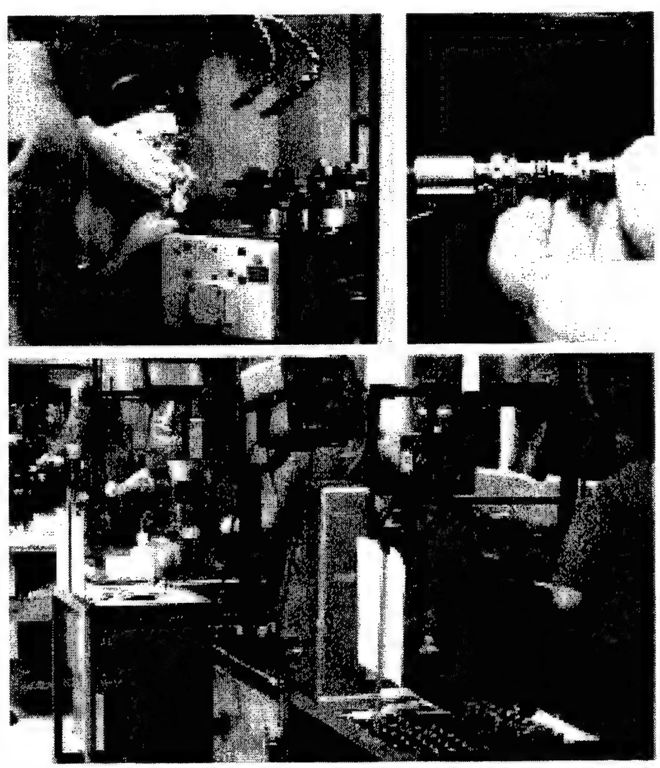


Figure 2-1. Ultra Precision Machining Services

With its can-do attitude, Strite found solutions to numerous, seemingly impossible problems. For the tire industry, the company designed tools that provide portable precision measuring capability where tolerances of less than 0.0002 inch are required on basic manufacturing tools with requirements of 0.002 inch at 1.5 meters (4.92 feet) from an optical inspection scope. Strite also developed extremely accurate perforation rolling tools to manufacture wire ribbon for use as heat sinks in oil and hydraulic fluid cooling. The uniqueness of this project was the thickness of the raw stock and the tolerance required throughout the manufacturing process. By applying lessons learned, precise machining skills, and material flow knowledge, Strite developed and produced a machine which proved to be more reliable, accurate, and productive in the manufacturing of the finished part.

Another heat exchange solution was Strite's adaptation of miniature tube bundles for spectrum analyzer applications. The company developed and fabricated a miniature heat exchanger which consisted of 20 small tubes (0.042-inch outside diameter each) swaged inside one large tube (0.231-inch inside diameter). The placement and containment of these tubes would present a major manufacturing problem to most companies of this size. Strite, on the other hand, with its can-do attitude and corporate experience, performs this type of work as part of its daily operations. As a result, various industries turn to Strite when they need solutions to their manufacturing problems.

Strite is currently addressing a very complex cryogenic cooling application for a satellite system. This system requires a flat spring that has a minimum operating life of 10 billion cycles at a continuous frequency of 60 Hertz. In collaboration with its customer and by using advanced materials and processes, Strite developed a process to mass produce flat springs with a life expectancy well in excess of one billion cycles. Strite expects to continue its development, and successfully meet the 10-billion cycle goal.

Flat springs are typically used in cryogenic coolers. One customer asked Strite to assist them in achieving measurable productivity improvements and cost reductions by developing new approaches in the manufacture of flat springs. The customer's existing method involved fabricating the flat springs out of SAE 1075 carbon material, followed by heat treating, and then using EDM to manufacture the springs to specification. This approach was expensive and time consuming. The customer wanted Strite to make these springs out of 301 stainless steel. After reviewing the project, Strite recommended that flat springs made from 420 stainless steel (used in some compressor valve springs and surgical knives) be tested as well. Strite experimented with water jet and laser cutting methods on these materials, and chose the laser process as the best approach to reducing manufacturing costs. Presently, the 301 and 420 stainless steels are being tested with the latter material emerging as the preferred option. By using 420 stainless steel and a laser cutting method, Strite is on the way to reducing its customer's manufacturing costs for flat springs by more than 75%.

These are a few examples of Strite's One-Stop Shopping capability. By providing its customers with best value solutions to difficult problems, Strite has gained a global reputation for engineering excellence in machining ultra precision components and subassemblies.

Skills Training

Acquiring and training the right people are fundamental ingredients for success in today's marketplace. During its rapid growth period between 1964 and 1967, Strite adopted several innovative employment practices which the company still uses today with excellent results. One of these practices involves the hiring of unskilled workers rather than skilled machinists. This practice enables Strite to train its employees from the ground up in an apprentice-type program.

Through its successful on-the-job training program, Strite creates a highly skilled and well-motivated workforce for the exacting requirements of ultra high precision machining operations. Although the company hires some individuals from the local community college, Strite routinely recruits many directly out of high school. Employees are trained in the set up, inspection, and troubleshooting aspects of a wide variety of machining operations, as well as how to work together in integrated teams. This approach produces a flexible and knowledgeable workforce who thinks in terms of concurrent engineering with six sigma quality; knows the importance of documentation; and strives for continuous improvement in the manufacturing process. In addition to meeting quality objectives, Strite's approach promotes employee involvement by giving the employee the expertise necessary to meet customers' requirements.

Strite encourages its employees to continue their education, and reimburses all collegiate courses and books that are applicable to the employee's job. If economic conditions permit, the company also gives bonuses to its employees based on position, length of service, and performance. Normally, layoffs do not occur, and employees are not required to retire when they reach 65 years of age.

Strite's employees have responded to this enlightened and innovative management and training approach with an unusually high sense of dedication and faithfulness to the company. More than one quarter of the employees have 25 years or more with the company. There are several examples of two-generation family members working at Strite, and at least one example of a three-generation family. Strite's commitment to its employees and their well-being engenders a sense of harmony, cooperation, efficiency, and family that is serving the company well as it competes in the global marketplace.

Section 3
Information

Production

SPEED System™ Orthodontics

Strite provides engineering and prototyping services to the scientific and research communities. The SPEED System™ orthodontic brackets, developed by Dr. G. Herbert Hanson (Hamilton, Ontario, Canada) in collaboration with Strite, are respected throughout the world as a superior orthodontic appliance. Shown in Figure 3-1, the SPEED appliance features a miniaturized, self-ligating design and uses resilient spring clips to replace ligatures. The spring clips entrap the arch wire with an easy closing mechanism that will not release prematurely; easily open without any special instruments; and eliminate the risk of ligature wounds. The SPEED System™ delivers an extremely light, corrective force that moves the teeth in a continual manner, reducing pain and shortening the total treatment time. The system's self-ligation typically reduces orthodontic visits by five to seven minutes.

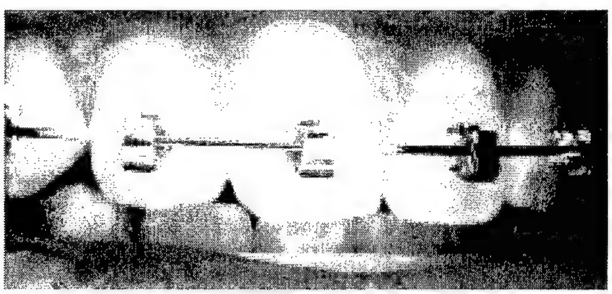


Figure 3-1. The SPEED Appliance

Strite's expertise in precision machining and manufacturing enabled the company to successfully produce the SPEED System™. The size of the bracket and the attachment of the hooks to the bracket created the most difficult problems for mass production. Strite developed innovative design and manufacturing processes needed to mass produce the SPEED brackets, and devised a specially-designed, automated brazing system for attaching the hooks.

Management

Quality Management System

Quality influences a company's ability to attain world-class status. Today's companies face a myriad of quality standards and systems which are imposed by their customers and changing market conditions. Quality standards such as the international standard (ISO 9000); the automotive standard (QS 9000); the new aerospace standard (SAE ARD 9000); and Boeing's D1-9000 standard were developed to assist suppliers in implementing basic quality systems. However, the sheer number of standards may impose too many checkpoints on a company's quality management system. The challenge is to devise an effective method for addressing all the requirements. In Strite's case, the company must also meet the FDA's Good Manufacturing Process certification requirements.

Strite is currently implementing ISO 9002 certification. Although the company is renowned for its close tolerance machining capabilities, Strite views the certification process as a welcome addition to its operations, and as a means to attract and keep customers during these highly competitive times. The company is already very effective in monitoring and controlling its product characteristics, process variables, and equipment characteristics. By implementing ISO 9002, Strite will enhance its existing methods, and enable the company to properly document and carry out its operations under controlled conditions. Strite's employees are also aware of the important role that process control plays in reducing variation, and actively support a stricter, more detailed requirement for documentation than required by ISO 9002.

In response to the automotive industry's requirements, Strite implemented a very effective Statistical Process Control (SPC) program. The company measures process capability ratios (Cpk) at several key points in its manufacturing processes to track its efforts for improving process capability. Strite's statistical techniques are an effective means of

improving process capability, and reducing variations in key product characteristics that affect customer satisfaction. Although the SPC program was initially used only for high volume production, the company discovered its usefulness for low volume runs as well. Strite is achieving Cpk ratios of 1.67, which is quite remarkable considering the close tolerances to which the company operates.

Strite recognizes the competitive value of a properly implemented and maintained quality management system. By using ISO 9000 as the basis of its quality management system and establishing buy-ins at all levels of the company, Strite is well positioned to respond to the most demanding of customers' requirements.

Appendix A
Table of Acronyms

Acronym	**Definition**
CNC	Computer Numerically Controlled
EDM	Electrical Discharge Machining
SPC	Statistical Process Control

Appendix B
BMP Survey Team

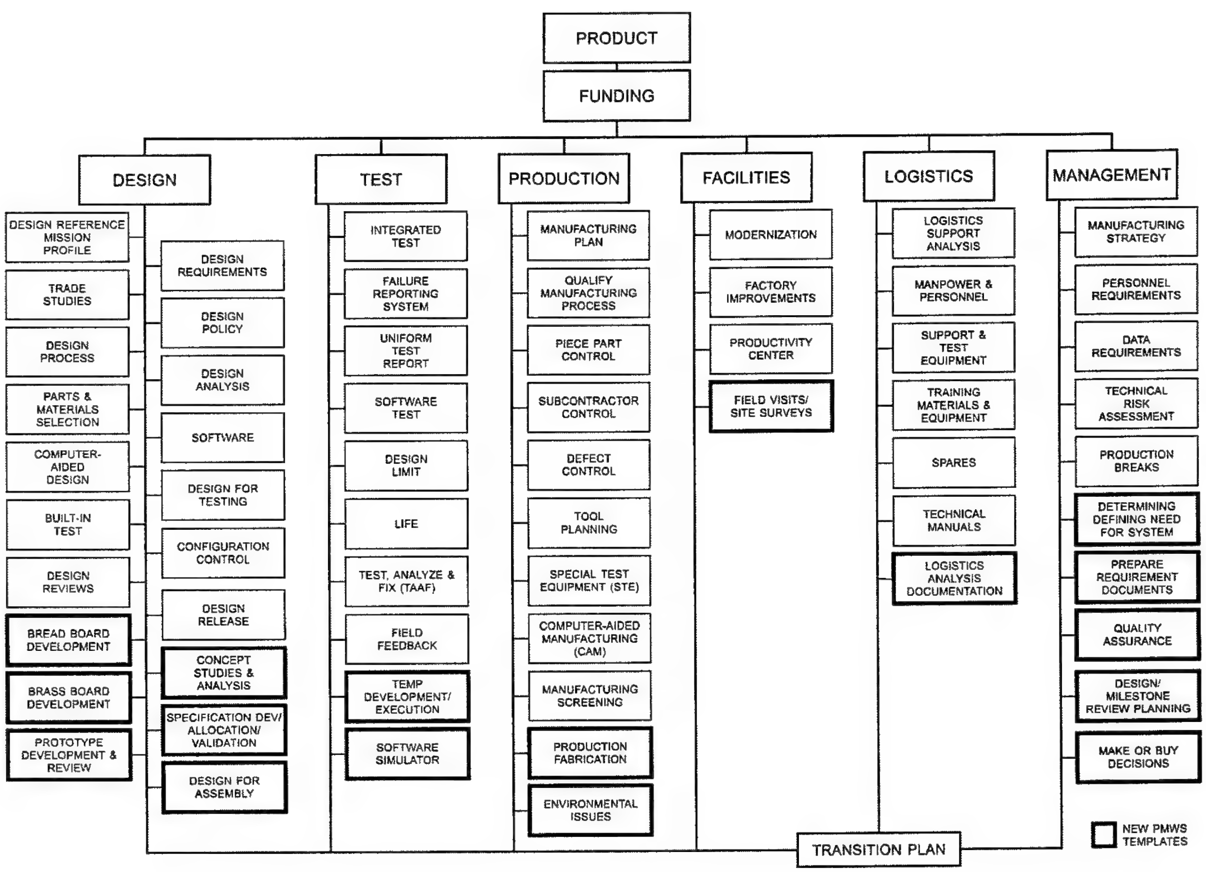
Team Member	Activity	Function
Larry Robertson (812) 854-5336	**Crane Division** **Naval Surface Warfare Center** Crane, IN	**Team Chairman**
Cheri Spencer (301) 403-8100	**BMP Center of Excellence** College Park, MD	**Technical Writer**
	Team	
Rick Purcell (301) 403-8100	**BMP Center of Excellence** College Park, MD	**Team Leader**
Dick Rumpf (703) 351-5080	**Rumpf and Associates** Arlington, VA	
Jack Tamargo (707) 642-4267	**BMP Satellite Center** Vallejo, CA	
Bob Atkinson (613) 954-3269	**Industry Canada** Ottawa, Ontario Canada	

Appendix C
Critical Path Templates and BMP Templates

This survey was structured around and concentrated on the functional areas of design, test, production, facilities, logistics, and management as presented in the Department of Defense 4245.7-M, *Transition from Development to Production* document. This publication defines the proper tools—or templates—that constitute the critical path for a successful material acquisition program. It describes techniques for improving the acquisition process by addressing it as an *industrial* process that focuses on the product's design, test, and production phases which are interrelated and interdependent disciplines.

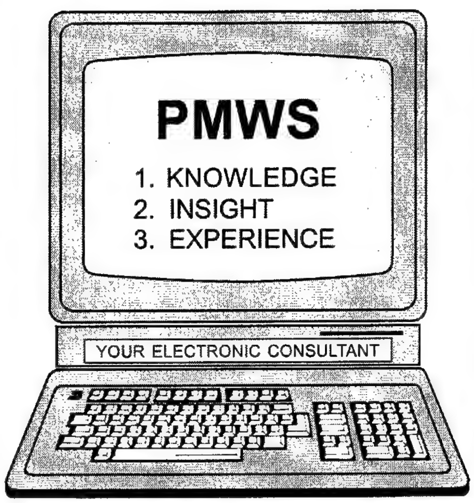
The BMP program has continued to build on this knowledge base by developing 17 new templates that complement the existing DOD 4245.7-M templates. These BMP templates address new or emerging technologies and processes.

"CRITICAL PATH TEMPLATES FOR TRANSITION FROM DEVELOPMENT TO PRODUCTION"



Appendix D
BMPnet and the Program Manager's WorkStation

The BMPnet, located at the Best Manufacturing Practices Center of Excellence (BMPCOE) in College Park, Maryland, supports several communication features. These features include the Program Manager's WorkStation (**PMWS**), electronic mail and file transfer capabilities, as well as access to Special Interest Groups (SIGs) for specific topic information and communication. The BMPnet can be accessed through the World Wide Web (at http://www.bmpcoe.org), through free software that connects directly over the Internet or through a modem. The PMWS software is also available on CD-ROM.



PMWS provides users with timely acquisition and engineering information through a series of interrelated software environments and knowledge-based packages. The main components of PMWS are KnowHow, SpecRite, the Technical Risk Identification and Mitigation System (TRIMS), and the BMP Database.

KnowHow is an intelligent, automated program that provides rapid access to information through an intelligent search capability. Information currently available in KnowHow handbooks includes Acquisition Streamlining, Non-Development Items, Value Engineering, NAVSO P-6071 (Best Practices Manual), MIL-STD-2167/2168 and the DoD 5000 series documents. KnowHow cuts document search time by 95%, providing critical, user-specific information in under three minutes.

SpecRite is a performance specification generator based on expert knowledge from all uniformed services. This program guides acquisition personnel in creating specifications for their requirements, and is structured for the build/approval process. SpecRite's knowledge-based guidance and assistance structure is modular, flexible, and provides output in MIL-STD 961D format in the form of editable WordPerfect® files.

TRIMS, based on DoD 4245.7-M (the transition templates), NAVSO P-6071, and DoD 5000 event-oriented acquisition, helps the user identify and rank a program's high-risk areas. By helping the user conduct a full range of risk assessments throughout the acquisition process, TRIMS highlights areas where corrective action can be initiated before risks develop into problems. It also helps users track key project documentation from concept through production including goals, responsible personnel, and next action dates for future activities.

The **BMP Database** contains proven best practices from industry, government, and the academic communities. These best practices are in the areas of design, test, production, facilities, management, and logistics. Each practice has been observed, verified, and documented by a team of government experts during BMP surveys.

Access to the BMPnet through dial-in or on Internet requires a special modem program. This program can be obtained by calling the BMPnet Help Desk at (301) 403-8179 or it can be downloaded from the World Wide Web at http://www.bmpcoe.org. To receive a user/e-mail account on the BMPnet, send a request to helpdesk@bmpcoe.org.

Appendix E
Best Manufacturing Practices Satellite Centers

There are currently eight Best Manufacturing Practices (BMP) satellite centers that provide representation for and awareness of the BMP program to regional industry, government and academic institutions. The centers also promote the use of BMP with regional Manufacturing Technology Centers. Regional manufacturers can take advantage of the BMP satellite centers to help resolve problems, as the centers host informative, one-day regional workshops that focus on specific technical issues.

Center representatives also conduct BMP lectures at regional colleges and universities; maintain lists of experts who are potential survey team members; provide team member training; identify regional experts for inclusion in the BMPnet SIG e-mail; and train regional personnel in the use of BMP resources such as the BMPnet.

The eight BMP satellite centers include:

California

Chris Matzke
BMP Satellite Center Manager
Naval Warfare Assessment Division
Code QA-21, P.O. Box 5000
Corona, CA 91718-5000
(909) 273-4992
FAX: (909) 273-4123
cmatzke@bmpcoe.org

Jack Tamargo
BMP Satellite Center Manager
257 Cottonwood Drive
Vallejo, CA 94591
(707) 642-4267
FAX: (707) 642-4267
jtamargo@bmpcoe.org

District of Columbia

Margaret Cahill
BMP Satellite Center Manager
U.S. Department of Commerce
14th Street & Constitution Avenue, NW
Room 3876 BXA
Washington, DC 20230
(202) 482-8226/3795
FAX: (202) 482-5650
mcahill@bxa.doc.gov

Illinois

Thomas Clark
BMP Satellite Center Manager
Rock Valley College
3301 North Mulford Road
Rockford, IL 61114
(815) 654-5515
FAX: (815) 654-4459
adme3tc@rvcux1.rvc.cc.il.us

Louisiana

Dr. Kenneth L. McManis
Director
Maritime Environmental Resources & Information Center
Gulf Coast Region Maritime Technology Center
University of New Orleans
810 Engineering Building
New Orleans, LA 70149
(504) 280-6271
FAX: (504) 280-5586
klmce@uno.edu

Michigan

Maureen H. Reilly
SAE/BMP Satellite Center Manager
3001 W. Big Beaver Road, Suite 320
Troy, MI 48084-3174
(724) 772-8564
FAX: (724) 776-0243
reilly@sae.org

Roy T. Trent
SAE/BMP Automotive Manufacturing Initiative Manager
3001 W. Big Beaver Road, Suite 320
Troy, MI 48084-3174
(248) 652-8461
FAX: (248) 652-8662
bounder@ees.eesc.com

Pennsylvania

Sherrie Snyder
BMP Satellite Center Manager
MANTEC, Inc.
P.O. Box 5046
York, PA 17405
(717) 843-5054, ext. 225
FAX: (717) 854-0087
snyderss@mantec.org

Tennessee

Tammy Graham
BMP Satellite Center Manager
Lockheed Martin Energy Systems
P.O. Box 2009, Bldg. 9737
M/S 8091
Oak Ridge, TN 37831-8091
(423) 576-5532
FAX: (423) 574-2000
tgraham@bmpcoe.org

Appendix F

Navy Manufacturing Technology Centers of Excellence

The Navy Manufacturing Sciences and Technology Program established the following Centers of Excellence (COEs) to provide focal points for the development and technology transfer of new manufacturing processes and equipment in a cooperative environment with industry, academia, and Navy centers and laboratories. These COEs are consortium-structured for industry, academia, and government involvement in developing and implementing technologies. Each COE has a designated point of contact listed below with the individual COE information.

Best Manufacturing Practices Center of Excellence

The Best Manufacturing Practices Center of Excellence (BMPCOE) provides a national resource to identify and promote exemplary manufacturing and business practices and to disseminate this information to the U.S. Industrial Base. The BMPCOE was established by the Navy's BMP program, Department of Commerce's National Institute of Standards and Technology, and the University of Maryland at College Park, Maryland. The BMPCOE improves the use of existing technology, promotes the introduction of improved technologies, and provides non-competitive means to address common problems, and has become a significant factor in countering foreign competition.

Point of Contact:
Mr. Ernie Renner
Best Manufacturing Practices Center of Excellence
4321 Hartwick Road
Suite 400
College Park, MD 20740
(301) 403-8100
FAX: (301) 403-8180
ernie@bmpcoe.org

Center of Excellence for Composites Manufacturing Technology

The Center of Excellence for Composites Manufacturing Technology (CECMT) provides a national resource for the development and dissemination of composites manufacturing technology to defense contractors and subcontractors. The CECMT is managed by the GreatLakes Composites Consortium and represents a collaborative effort among industry, academia, and government to develop, evaluate, demonstrate, and test composites manufacturing technologies. The technical work is problem-driven to reflect current and future Navy needs in the composites industrial community.

Point of Contact:
Dr. Roger Fountain
Center of Excellence for Composites Manufacturing Technology
103 Trade Zone Drive
Suite 26C
West Columbia, SC 29170
(803) 822-3705
FAX: (803) 822-3730
rfglcc@glcc.org

Electronics Manufacturing Productivity Facility

The Electronics Manufacturing Productivity Facility (EMPF) identifies, develops, and transfers innovative electronics manufacturing processes to domestic firms in support of the manufacture of affordable military systems. The EMPF operates as a consortium comprised of industry, university, and government participants, led by the American Competitiveness Institute under a CRADA with the Navy.

Point of Contact:
Mr. Alan Criswell
Electronics Manufacturing Productivity Facility
Plymouth Executive Campus
Bldg 630, Suite 100
630 West Germantown Pike
Plymouth Meeting, PA 19462
(610) 832-8800
FAX: (610) 832-8810
http://www.engriupui.edu/empf/

National Center for Excellence in Metalworking Technology

The National Center for Excellence in Metalworking Technology (NCEMT) provides a national center for the development, dissemination, and implementation of advanced technologies for metalworking products and processes. The NCEMT, operated by Concurrent Technologies Corporation, helps the Navy and defense contractors improve manufacturing

productivity and part reliability through development, deployment, training, and education for advanced metalworking technologies.

Point of Contact:
Mr. Richard Henry
National Center for Excellence in Metalworking Technology
1450 Scalp Avenue
Johnstown, PA 15904-3374
(814) 269-2532
FAX: (814) 269-2799
henry@ctc.com

Navy Joining Center

The Navy Joining Center (NJC) is operated by the Edison Welding Institute and provides a national resource for the development of materials joining expertise and the deployment of emerging manufacturing technologies to Navy contractors, subcontractors, and other activities. The NJC works with the Navy to determine and evaluate joining technology requirements and conduct technology development and deployment projects to address these issues.

Point of Contact:
Mr. David P. Edmonds
Navy Joining Center
1100 Kinnear Road
Columbus, OH 43212-1161
(614) 487-5825
FAX: (614) 486-9528
dave_edmonds@ewi.org

Energetics Manufacturing Technology Center

The Energetics Manufacturing Technology Center (EMTC) addresses unique manufacturing processes and problems of the energetics industrial base to ensure the availability of affordable, quality energetics. The focus of the EMTC is on process technology with a goal of reducing manufacturing costs while improving product quality and reliability. The COE also maintains a goal of development and implementation of environmentally benign energetics manufacturing processes.

Point of Contact:
Mr. John Brough
Energetics Manufacturing Technology Center
Indian Head Division
Naval Surface Warfare Center
Indian Head, MD 20640-5035
(301) 743-4417
DSN: 354-4417
FAX: (301) 743-4187
mt@command.nosih.sea06.navy.mil

Manufacturing Science and Advanced Materials Processing Institute

The Manufacturing Science and Advanced Materials Processing Institute (MS&AMPI) is comprised of three centers including the National Center for Advanced Drivetrain Technologies (NCADT), The Surface Engineering Manufacturing Technology Center (SEMTC), and the Laser Applications Research Center (LaserARC). These centers are located at The Pennsylvania State University's Applied Research Laboratory. Each center is highlighted below.

Point of Contact for MS&AMPI:
Mr. Henry Watson
Manufacturing Science and Advanced Materials Processing Institute
ARL Penn State
P.O. Box 30
State College, PA 16804-0030
(814) 865-6345
FAX: (814) 863-1183
hew2@psu.edu

- **National Center for Advanced Drivetrain Technologies**
  The NCADT supports DoD by strengthening, revitalizing, and enhancing the technological capabilities of the U.S. gear and transmission industry. It provides a site for neutral testing to verify accuracy and performance of gear and transmission components.

  Point of Contact for NCADT:
  Dr. Suren Rao
  NCADT/Drivetrain Center
  ARL Penn State
  P.O. Box 30
  State College, PA 16804-0030
  (814) 865-3537
  FAX: (814) 863-6185
  http://www.arl.psu.edu/drivetrain_center.html/

- **Surface Engineering Manufacturing Technology Center**

  The SEMTC enables technology development in surface engineering—the systematic and rational modification of material surfaces to provide desirable material characteristics and performance. This can be implemented for complex optical, electrical, chemical, and mechanical functions or products that affect the cost, operation, maintainability, and reliability of weapon systems.

  Point of Contact for SEMTC:
  Dr. Maurice F. Amateau
  SEMTC/Surface Engineering Center
  P.O. Box 30
  State College, PA 16804-0030
  (814) 863-4214
  FAX: (814) 863-0006
  http://www/arl.psu.edu/divisions/arl_org.html

- **Laser Applications Research Center**

  The LaserARC is established to expand the technical capabilities of DOD by providing access to high-power industrial lasers for advanced material processing applications. LaserARC offers basic and applied research in laser-material interaction, process development, sensor technologies, and corresponding demonstrations of developed applications.

  Point of Contact for LaserARC:
  Mr. Paul Denney
  Laser Center
  ARL Penn State
  P.O. Box 30
  State College, PA 16804-0030
  (814) 865-2934
  FAX: (814) 863-1183
  http://www/arl.psu.edu/divisions/arl_org.html

Gulf Coast Region Maritime Technology Center

The Gulf Coast Region Maritime Technology Center (GCRMTC) is located at the University of New Orleans and will focus primarily on product developments in support of the U.S. shipbuilding industry. A sister site at Lamar University in Orange, Texas will focus on process improvements.

Point of Contact:
Dr. John Crisp
Gulf Coast Region Maritime Technology Center
University of New Orleans
Room N-212
New Orleans, LA 70148
(504) 286-3871
FAX: (504) 286-3898

Appendix G
Completed Surveys

As of this publication, 102 surveys have been conducted and published by BMP at the companies listed below. Copies of older survey reports may be obtained through DTIC or by accessing the BMPnet. Requests for copies of recent survey reports or inquiries regarding the BMPnet may be directed to:

Best Manufacturing Practices Program
4321 Hartwick Rd., Suite 400
College Park, MD 20740
Attn: Mr. Ernie Renner, Director
Telephone: 1-800-789-4267
FAX: (301) 403-8180
ernie@bmpcoe.org

1985	Litton Guidance & Control Systems Division - Woodland Hills, CA
1986	Honeywell, Incorporated Undersea Systems Division - Hopkins, MN (Alliant TechSystems, Inc.) Texas Instruments Defense Systems & Electronics Group - Lewisville, TX General Dynamics Pomona Division - Pomona, CA Harris Corporation Government Support Systems Division - Syosset, NY IBM Corporation Federal Systems Division - Owego, NY Control Data Corporation Government Systems Division - Minneapolis, MN
1987	Hughes Aircraft Company Radar Systems Group - Los Angeles, CA ITT Avionics Division - Clifton, NJ Rockwell International Corporation Collins Defense Communications - Cedar Rapids, IA UNISYS Computer Systems Division - St. Paul, MN (Paramax)
1988	Motorola Government Electronics Group - Scottsdale, AZ General Dynamics Fort Worth Division - Fort Worth, TX Texas Instruments Defense Systems & Electronics Group - Dallas, TX Hughes Aircraft Company Missile Systems Group - Tucson, AZ Bell Helicopter Textron, Inc. - Fort Worth, TX Litton Data Systems Division - Van Nuys, CA GTE C^3 Systems Sector - Needham Heights, MA
1989	McDonnell-Douglas Corporation McDonnell Aircraft Company - St. Louis, MO Northrop Corporation Aircraft Division - Hawthorne, CA Litton Applied Technology Division - San Jose, CA Litton Amecom Division - College Park, MD Standard Industries - LaMirada, CA Engineered Circuit Research, Incorporated - Milpitas, CA Teledyne Industries Incorporated Electronics Division - Newbury Park, CA Lockheed Aeronautical Systems Company - Marietta, GA Lockheed Corporation Missile Systems Division - Sunnyvale, CA Westinghouse Electronic Systems Group - Baltimore, MD General Electric Naval & Drive Turbine Systems - Fitchburg, MA Rockwell International Corporation Autonetics Electronics Systems - Anaheim, CA TRICOR Systems, Incorporated - Elgin, IL
1990	Hughes Aircraft Company Ground Systems Group - Fullerton, CA TRW Military Electronics and Avionics Division - San Diego, CA MechTronics of Arizona, Inc. - Phoenix, AZ Boeing Aerospace & Electronics - Corinth, TX Technology Matrix Consortium - Traverse City, MI Textron Lycoming - Stratford, CT

1991	*Resurvey of Litton Guidance & Control Systems Division* - Woodland Hills, CA Norden Systems, Inc. - Norwalk, CT Naval Avionics Center - Indianapolis, IN United Electric Controls - Watertown, MA Kurt Manufacturing Co. - Minneapolis, MN MagneTek Defense Systems - Anaheim, CA Raytheon Missile Systems Division - Andover, MA AT&T Federal Systems Advanced Technologies and AT&T Bell Laboratories - Greensboro, NC and Whippany, NJ *Resurvey of Texas Instruments Defense Systems & Electronics Group* - Lewisville, TX
1992	Tandem Computers - Cupertino, CA Charleston Naval Shipyard - Charleston, SC Conax Florida Corporation - St. Petersburg, FL Texas Instruments Semiconductor Group Military Products - Midland, TX Hewlett-Packard Palo Alto Fabrication Center - Palo Alto, CA Watervliet U.S. Army Arsenal - Watervliet, NY Digital Equipment Company Enclosures Business - Westfield, MA and Maynard, MA Computing Devices International - Minneapolis, MN *(Resurvey of Control Data Corporation Government Systems Division)* Naval Aviation Depot Naval Air Station - Pensacola, FL
1993	NASA Marshall Space Flight Center - Huntsville, AL Naval Aviation Depot Naval Air Station - Jacksonville, FL Department of Energy Oak Ridge Facilities (Operated by Martin Marietta Energy Systems, Inc.) - Oak Ridge, TN McDonnell Douglas Aerospace - Huntington Beach, CA Crane Division Naval Surface Warfare Center - Crane, IN and Louisville, KY Philadelphia Naval Shipyard - Philadelphia, PA R. J. Reynolds Tobacco Company - Winston-Salem, NC Crystal Gateway Marriott Hotel - Arlington, VA Hamilton Standard Electronic Manufacturing Facility - Farmington, CT Alpha Industries, Inc. - Methuen, MA
1994	Harris Semiconductor - Melbourne, FL United Defense, L.P. Ground Systems Division - San Jose, CA Naval Undersea Warfare Center Division Keyport - Keyport, WA Mason & Hanger - Silas Mason Co., Inc. - Middletown, IA Kaiser Electronics - San Jose, CA U.S. Army Combat Systems Test Activity - Aberdeen, MD Stafford County Public Schools - Stafford County, VA
1995	Sandia National Laboratories - Albuquerque, NM Rockwell Defense Electronics Collins Avionics & Communications Division - Cedar Rapids, IA *(Resurvey of Rockwell International Corporation Collins Defense Communications)* Lockheed Martin Electronics & Missiles - Orlando, FL McDonnell Douglas Aerospace (St. Louis) - St. Louis, MO *(Resurvey of McDonnell-Douglas Corporation McDonnell Aircraft Company)* Dayton Parts, Inc. - Harrisburg, PA Wainwright Industries - St. Peters, MO Lockheed Martin Tactical Aircraft Systems - Fort Worth, TX *(Resurvey of General Dynamics Fort Worth Division)* Lockheed Martin Government Electronic Systems - Moorestown, NJ Sacramento Manufacturing and Services Division - Sacramento, CA JLG Industries, Inc. - McConnellsburg, PA
1996	City of Chattanooga - Chattanooga, TN Mason & Hanger Corporation - Pantex Plant - Amarillo, TX Nascote Industries, Inc. - Nashville, IL Weirton Steel Corporation - Weirton, WV NASA Kennedy Space Center - Cape Canaveral, FL Department of Energy, Oak Ridge Operations - Oak Ridge, TN

1997	Headquarters, U.S. Army Industrial Operations Command - Rock Island, IL SAE International and Performance Review Institute - Warrendale, PA Polaroid Corporation - Waltham, MA Cincinnati Milacron, Inc. - Cincinnati, OH Lawrence Livermore National Laboratory - Livermore, CA Sharretts Plating Company, Inc. - Emigsville, PA Thermacore, Inc. - Lancaster, PA Rock Island Arsenal - Rock Island, IL Northrop Grumman Corporation - El Segundo, CA *(Resurvey of Northrop Corporation Aircraft Division)* Letterkenny Army Depot - Chambersburg, PA Elizabethtown College - Elizabethtown, PA Tooele Army Depot - Tooele, UT
1998	United Electric Controls - Watertown, MA Strite Industries Limited - Cambridge, Ontario, Canada

INTERNET DOCUMENT INFORMATION FORM

A . Report Title: Best Manufacturing Practices: Report of Survey Conducted at Strite Industries Limited, Cambridge, Ontario, Canada

B. DATE Report Downloaded From the Internet: 01/14/02

C. Report's Point of Contact: (Name, Organization, Address, Office Symbol, & Ph #): Best Manufacturing Practices
Center of Excellence
College Park, MD

D. Currently Applicable Classification Level: Unclassified

E. Distribution Statement A: Approved for Public Release

F. The foregoing information was compiled and provided by:
DTIC-OCA, Initials: __VM__ Preparation Date 01/14/02

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